2. If the above contrast exists, what is the reason for it? I have suggested that the difference in thermal regimes may be responsible, and have proposed mechanisms of inclusion beneath cold ice in Spitsbergen. Dr Andrews says that the debris in the Barnes Ice Cap is incorporated in the terminal zone. It would be very interesting to have details of the sections quoted by him and an opinion of whether they are compatible with Weertman's (1961) hypothesis for Baffin Island glaciers of an origin by basal freezing.

3. In answer to Dr Andrews' query. It is true that many temperate glaciers have large terminal and lateral ice-cored moraines. I believe this stems from the fact that many such glaciers are valley glaciers in which englacial debris is introduced not from the bed but from valley sides, nunataks and cirque headwalls. Where these latter features do not occur, there is almost no englacial debris above the basal layer. Cold ice caps with no source of supraglacial material do, however, contain englacial debris and produce large terminal ice-cored moraines.

School of Environmental Sciences,   G. S. BOULTON
    University of East Anglia,
        Norwich NOR 88C, England
            25 May 1971

REFERENCE

Weertman, J. 1961. Mechanism for the formation of inner moraines found near the edge of cold ice caps and ice sheets. *Journal of Glaciology*, Vol. 3, No. 30, p. 965–78.

SIR,   *On present-day glaciers in the U.S.S.R.*

In a recent paper Grosval'd and Kotlyakov (1969) review various Soviet glaciological projects. In particular, they discuss mass balance figures for Lednik IGAN, in the Polar Urals, computed for the period since 1818 using meteorological data recorded at the weather station at Syktyvkar. They place stress on the fact that there appears to exist a 22-year periodicity in the plot of the 10-year running mean of net mass balance and they speculate on the relationship this bears to the 22-year fluctuations in solar activity. In view of the interest of the current IHD in the glacier-climate problem these results of Grosval'd and Kotlyakov merit some discussion.

First, the relationship used (maximum snow accumulation *versus* sum of the average monthly temperature and the total ablation *versus* the sum of mean monthly temperatures for the summer) seem rather too simple *a priori* to give a good "explanation" of the data observed over only 11 years of actual field work. The authors claim that the correlation is "satisfactory" but do not mention the form of relationship (regression equation) or discuss the "goodness" of fit of the data to the predictive equations. It is not stated whether the computed correlation coefficients were reduced to take account of the probability of an observed higher correlation arising randomly from a universe with a lower true correlation. With a sample size of 10 an observed correlation of 0.90, for example, must be reduced to 0.72 (which would "explain" just less than half of the observed data) for significance at the 5% level (Ezekiel and Fox, 1967, p. 294).

Secondly, it is not clear whether the meteorological data, used in establishing the relationships mentioned and valid for 11 years, were collected over or near the glacier or at Syktyvkar, but in the former case there would be need for a relationship between meteorological parameters at the glacier and at Syktyvkar. In this connection it might be mentioned that Syktyvkar is apparently located about 900 km away from Lednik IGAN and on the opposite side of the Ural Mountains (the authors do not say where Syktyvkar is).

Further, by plotting the extrapolated mass-balance data in 10-year running mean form, the authors encounter difficulties due to the Slutzky effect (Slutzky, 1937; Mitchell and others, 1966) whereby a running mean acts as a mathematical filter. In general, a time series will consist of a sum of Fourier components (a purely random series will have a white spectrum) and the filter will selectively amplify or damp constituent components according to frequency to give rise to a new filtered or distorted time series. The authors' graph of the 10-year running mean net budget represents a filtered time series and the prominance of the 22-year cycle is probably due to this filtering effect, likewise the phase difference between the 10-year mean for Lednik IGAN and the 5-year mean for the Grosser Aletschgletscher.

Mitchell and others (1966) and Lliboutry (1964–65, Tom. 2, p. 829–32) outline procedures by which the unfiltered time series could be analysed for periodicity and trend if this were felt desirable in the light of the objections previously raised.

With regard to the question of a relationship between solar activity and variations in glacier net balance it should be axiomatic that, if a relationship does exist, it is by way of the atmospheric circulation. However, the problem lies in relating variations in radiation from the sun in the ultra-violet region of the spectrum (absorbed chiefly by ozone and oxygen in the stratosphere and thermosphere respectively) and variations in corpuscular radiation (interacting with the magnetic field of the earth) with gross circulation changes in the troposphere.

Faculty of Graduate Studies and Research,   R. J. BRAITHWAITE
     McGill University,
          Montreal 110, Quebec, Canada
               14 November 1970

REFERENCES

Ezekiel, M., *and* Fox, K. A. 1967. *Methods of correlation and regression analysis.* New York, John Wiley and Sons Inc.

Grosval'd, M. G., *and* Kotlyakov, V. M. 1969. Present-day glaciers in the U.S.S.R. and some data on their mass balance. *Journal of Glaciology*, Vol. 8, No. 52, p. 9–22.

Lliboutry, L. A. 1964–65. *Traité de glaciologie.* Paris, Masson et Cie. 2 vols.

Mitchell, J. M., jr., *and others.* 1966. Climatic change. Report of a working group of the Commission for Climatology prepared by J. M. Mitchell, Jr., chairman [and six others]. *W.M.O. Technical Note* No. 79.

Slutzky, E. 1937. The summation of random causes as the source of cyclic processes. *Econometrica*, Vol. 5, No. 2, p. 105–46.

SIR,   *Refraction seismic investigation at Zemu Glacier, Sikkim:*
               comments on the paper of R. N. Bose, N. P. Dutta and S. M. Lahiri

It happens rather often that former glaciological work has been done in vain because succeeding explorers do not know about it. This is particularly bad in cases when such things as special glacier maps remain unknown, which could provide valuable information and data for following studies.

The seismic investigations at Zemu Glacier, Sikkim, (Bose and others, 1971) may be an example. The authors have carefully studied and used the work of several predecessors, but have obviously not known and therefore not used the glacier map of the Zemu which has been published together with a detailed article on the same glacier (Wien, 1933). The map shows the state of the glacier in 1931 and, together with other data in the article, can be compared with the results of the recent work. To give an example: the seismic cross-section measured in 1965 could be studied together with the velocity profiles across the glacier measured by photogrammetry in 1931 at altitudes of 5 250 and 4 600 m, the latter rather near the recent seismic section at 4 500 m. The ice depth of 310 m at this section (Bose and others, 1971, fig. 9, p. 119) shows that the thickness of 220 m which Finsterwalder (1933) computed by using Somigliana's and Lagally's formula for a place higher up and nearer the equilibrium line (at about 5 400 m) is probably much too small. This is another example of the fact which has become well known in the meantime, that the ice depth cannot be determined from values of the surface velocities.

Perhaps a bibliography of glacier maps and other existing data arranged in a geographical order could change the present unsatisfactory situation, as a result of which valuable glaciological work remains unused. Such a bibliography could be confined to remote regions where literature is obviously difficult to discover and to obtain. It should contain old reports, papers, sketches, pictures, and maps, together with complete references and short notes about the information which can be expected. Such a survey on former literature would be a valuable contribution to the IHD.

Macheinerweg 35,   W. KICK
     Regensburg, Germany
          8 April 1971